

Case 3635***Antheraea roylei* Moore, 1859 (Insecta, Lepidoptera, SATURNIIDAE):
proposed conservation**

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Abstract. The purpose of this application, under Article 81.1 of the Code, is to conserve the name *Antheraea roylei* Moore, 1859 believed to be the progenitor of *Bombyx (Saturnia) pernyi* Guérin-Méneville, 1855 (currently *Antheraea pernyi*). Tussah silk is second only to mulberry silk (from *Bombyx mori*) in world production and consumption. Recently compiled evidence indicates that the tussah silkworm, also called the Chinese oak silkworm, *Antheraea pernyi* Guérin-Méneville, 1855, was derived thousands of years ago in China from the Himalayan *Antheraea roylei* Moore, 1859, which would place the latter in synonymy under the former, since the two names refer to the same biological species. Although there are no significant and consistent differences in wing pattern and genitalia, both names have had wide usage for more than 150 years, and the two entities differ in their chromosome numbers and cocoon structure. The name *A. roylei* has been applied by almost all authors to wild collected material in India, Burma, Nepal, Thailand, etc., while the name *A. pernyi* has been used by Chinese and Korean authors for sericultural populations and wild collected specimens in southern China, although the wild collected material does not differ from that of countries that share borders with southern China. The authors propose that the name *Antheraea roylei* be conserved and added to the Official List of Specific Names in Zoology.

Keywords. Nomenclature; taxonomy; *Antheraea pernyi*; *Antheraea roylei*; Chinese oak silkworm; Himalayan oak silkworm; oak tasar silk; tussah silkworm.

1. The name *Bombyx (Saturnia) pernyi* was established by Guérin-Méneville (1855, pp. 297–298, pl. 6, fig. 1), who provided a formal Latin description within his French text. It has been recognized by the name *Antheraea pernyi* for more than a century. The Himalayan oak silkworm, *Antheraea roylei* was described by Moore (in Horsfield & Moore, [1860], p. 397; for publication date of the catalogue see Cowan (1975)). The moth was also described in another work by Moore (1859, p. 256, pl. 64, fig. 1) that was actually published prior to the catalogue of Horsfield & Moore. Therefore the correct publication date and reference is Moore (1859). In Moore (1859) the name was misspelled as *roylii*, but Nässig & Holloway (2010) concluded that the name should be spelled *roylei*, citing the relevant articles of the Code, and pointing out that

the spelling *roylei* had been used consistently in publications for 140 years. Nässig & Holloway also verified the correct publication date for the original description as 1859, and provided evidence that the species was named after J. Forbes Royle (1856). To our knowledge the spelling *Antheraea roylia* Moore, 1859 has not been used since 1900 thereby satisfying the conditions of Article 23.9.1.1 of the Code, while *Antheraea roylei* Moore, 1859 has been used in multiple publications satisfying the conditions of Article 23.9.1.2 of the Code. To confirm that the spelling *roylei* is the one to be used we declare the name *Antheraea roylia* Moore, 1859 a nomen oblitum under Article 23.9.2 of the Code.

2. The senior author has examined the original type specimens of *Bombyx (Saturnia) pernyi* in the Muséum National d'Histoire Naturelle in Paris. Moreover, we recently received colour images of a syntype male of *Antheraea roylei* Moore by the courtesy of the Natural History Museum (Entomology), and could thus confirm the identity of this taxon.

3. As detailed by Peigler (2012), there is now a preponderance of evidence that *roylei* and *pernyi* are biologically the same species, indicating that the latter was derived from the former by artificial selection in China more than two millennia ago (see Liu et al., 2010). The evidence compiled and documented by Peigler included the points that all wild collected specimens reported from China are assigned the name *pernyi*, whilst ones reported by authors from Nepal, Thailand, Burma, Vietnam, West Malaysia, and Himalayan regions of India are almost always called *roylei*. Cultures of *pernyi* that were introduced into Spain and Japan in the 19th century and into Romania and Ukraine in the 20th century always failed to establish, or persisted less than ten years (Szekely, 2010, p. 38). Field collections of *pernyi* in South Korea are so rare (single specimens taken in 1924, 1938, and 1992, two of which were on small islands, see Park & Tshistjakov, 1999), that they are assumed to represent escapees from sericultural colonies (Peigler, 2012). Sericultural hybrids derived in India in the 1970s and 1980s by crossing *roylei* with *pernyi* produced viable offspring for multiple generations (Jolly et al., 1979), which appeared to be an exception to the 'biological species concept.' Thus, we consider the two names to apply to the same biological species, with *roylei* being the wild progenitor, and *pernyi* being the derivative by artificial selection.

4. Not surprisingly then, *pernyi* and *roylei* do not have consistent wing pattern characters to separate them, because the moths are variable and the variability overlaps. The larvae look the same and the genitalia (used to separate closely related species in many groups of Lepidoptera) do not differ. However, *pernyi* and *roylei* do differ significantly in the structure of their cocoons and their chromosome numbers. The cocoons of *A. pernyi* are compact and ovoid, and contain 750–810 continuous metres of silk, whilst cocoons of *roylei* are double with an inflated irregular outer cocoon and a compact inner cocoon, and contain only 175–210 continuous metres of silk (Devi et al., 2011). *Antheraea roylei* has a chromosome number of $n = 31$, which is the modal and probably ancestral number for most SATURNIIDAE, but the chromosome number for *A. pernyi* is $n = 49$ (Belyakova & Lukhtanov, 1994, 1996).

5. Two entities could be routinely and easily separated by the fact that *A. roylei* is the one that is collected in the wild, but *A. pernyi* exists in captive colonies. However, occasionally cocoons or moths of *A. pernyi* are found in the wild, as escapees from captive colonies (Yang, 1978), because most of the rearing is done outdoors on

pruned oaks. Even so, most tussah silk culture is carried out in the northeast (provinces of Liaoning, Shandong, Anhui and Henan) where no wild populations exist. Records for the natural distribution of *A. roylei* are in the southern provinces of Fujian, Jiangxi, Hunan, Sichuan, Yunnan, Guangdong and Guangxi. There is one record from southern Shaanxi, west of the primary region of tussah sericulture. Thus, the geographical source of a specimen would also provide evidence to assign it to either *roylei* or *pernyi*.

6. Three silkmoths are apparently entirely of sericultural origin and do not exist in nature, namely *Bombyx mori*, *Samia ricini* and *Antheraea pernyi*. The following traits characterise these three silkmoth species: inability to establish and maintain feral populations, they are easy to mass-rear indoors, the larvae are highly disease-resistant, cocoons have excessive amounts of silk, cocoons have few or no peduncles (attachments to stems), and in the case of the first two, adult moths do not fly. The aforementioned silkmoths have the last two traits listed by Clutton-Brock (1981, pp. 15–16) for species that are amenable to domestication. Peigler (2012) put forth a hypothesis that developing the sericultural insect would be favoured if that were carried out in a region to the north of where wild populations occur, so that gene flow would not interfere with the artificial selection process, and we believe that this was what happened.

7. The alternative solution to this problem is to accept the synonymy and treat the wild and sericultural populations as *pernyi*. However, this would lead to excessive confusion, especially in countries to the south of China, where wild collected specimens are almost always identified as *roylei* (e.g. Arora & Gupta, 1979; Pinratana & Lampe, 1990; Haruta, 1992; Allen, 1993; Singh & Suryanarayana, 2005; Kakati & Chutia, 2009; Sharma et al., 2010; Chutia & Kakati, 2011; Devi et al., 2011; Kavane & Sathe, 2011).

8. By contrast, authors treating the Chinese fauna have been calling wild collected specimens *pernyi* in virtually all of their published surveys (e.g. Yang, 1978; Zhang, 1986; Wang, H.-Y., 1988; Wang, L.-Y., 1988, 1992; Guo, 1988; Lu, 1990; Wu & Lin, 1995; Zhu & Wang, 1996; Wu & Li, 1997; Fang, 2003; Fu & Tzuoo, 2004; Zhao & Li, 2005; Li et al., 2011), and some would probably prefer to maintain the *status quo* in that regard, so some opposition to this proposal might be expected from entomologists in China. However, we believe that it would best serve Chinese entomology in the long term if both names were available to distinguish the wild and domesticated forms. Interestingly, Mell (1939, p. 143), a German who collected insects in China for years, used the name *A. roylei* for his wild-collected material, and Sonan (1937), a Japanese entomologist working in Taiwan, did the same.

9. Major taxonomic catalogues and monographs on SATURNIIDAE or sericulture (e.g. Horsfield & Moore, [1860]; Simmonds, 1869 (p. 599) ; Hutton, 1872; Wardle, 1879; Cotes & Swinhoe, [1889]; Cotes, 1891–1893; Sonthonnax, 1901; Quajat, 1904, pp. 26, 45; Schüssler, 1933; Bouvier, 1936; Cooper, 1942; Lampe, 2010; Meister, 2011) have all treated *pernyi* as the northern Chinese insect and *roylei* as the Himalayan one. In the classic series edited by Adalbert Seitz, *The Macrolepidoptera of the World*, the taxon *A. pernyi* was treated in a volume on Palearctic moths (Jordan, 1911a, b, p. 216), whilst *A. roylei* was covered in another on Indo-Australian moths (Seitz, 1926a, b, p. 511). In his catalogue covering larger moths, Kirby (1892,

pp. 758–759) listed *roylei* from Darjeeling and *pernyi* from North China. Packard (1914, p. 201) cited *roylei* as a subspecies of *pernyi*, but virtually no other authors have treated these taxa as trinomina.

10. Additional publications on more specialised topics (Belyakova & Lukhtanov, 1994, 1996; Peigler & Naumann, 2003, p. 64; Regier et al., 2005; Mahendran et al., 2006; Holloway, 2011) used both names *roylei* and *pernyi*, treating the two entities as separate.

11. Crosses between *pernyi* and *roylei* were already made in the 19th century (Hutton, 1872; Wailly, 1882), and names were applied to them (Tutt, 1901). Beginning in the 1970s, these ‘hybrids’ were re-named *A. proylei* Jolly by Indian sericulturists, and in the 1980s and 1990s these stocks became the basis for ‘oak tasar’ or ‘temperate tasar’ silk, as distinguished from India’s traditional ‘tropical tasar’ silk, based on *Antheraea paphia* (Linnaeus 1758) (= *A. mylitta* Drury 1773). Much attention has been given to these Himalayan cultures called *proylei* by Indian sericulturists (Jolly et al., 1979; Singh & Suryanarayana, 2005; CSB, 2006; Sharma et al., 2010), although Srivastav & Thangavelu (2005, p. 103) reported that ‘cytogenetically, morphologically and physiologically both stocks [*pernyi* and *proylei*] appear to be the same.’

12. Aside from the taxonomic confusion and instability that would result by synonymising the names *pernyi* and *roylei*, loss of the latter name could hinder efforts to conserve wild populations in the countries having territory in the Himalayas, including China. Conservation of this progenitor is desirable because tussah silk is second only to mulberry silk (from *Bombyx mori*) in world commerce. Chinese sericulturists maintain over 130 named varieties of *A. pernyi*, primarily in Liaoning, and they are continually developing new strains (SRIL, 1994), so the need to protect populations of the wild form as a genetic resource cannot be overstated. How could the case be made that wild populations of *pernyi* be conserved, when the species exists abundantly and securely in captivity? Indeed, it may be harder to promote and fund conservation programmes aimed at protecting wild populations of an insect that carries the same name, than if there were two names.

13. The two moths do not behave the same way, nor are they used in the same way by humans. *Antheraea roylei* is difficult to mass-rear in captivity, and its cocoons are of minimal use (Chutia & Kakati, 2011). As mentioned above, *Antheraea pernyi* apparently cannot be permanently established as feral populations, but its cocoons have great economic value. In our opinion, the two need to carry different binomials. Opinion 2027 (BZN 60(1): 74–75, March 2003) provides an excellent precedent for this proposed action. Both authors work on taxonomy and sericulture of SATURNIIDAE (Peigler, 1993, 1999, 2012; Peigler & Naumann, 2003; Chutia & Kakati, 2011; Kakati & Chutia, 2009), and they hope to be able to use the names *pernyi* and *roylei* to refer to the separate entities in their future publications. Similar to authors of Case 3010 that resulted in Opinion 2027 our application seeks to stabilize the names of the wild species whether or not domestic forms are considered as ‘conspecific’, i.e. can be included in the same species. We are asking for a nomenclatural rather than a taxonomic decision, and are not concerned with the ongoing discussion on the nomenclature of domestic animals. Whatever view on the conspecificity and derivation of domestic and wild taxa was taken, both groups are recognizable entities thereby creating two different areas of application of both groups of names. A Commission’s ruling can be a justification for using the junior names in practical situations, such as conservation of wild populations.

14. The International Commission on Zoological Nomenclature is accordingly asked:

- (1) to use its plenary power to rule that the name *roylei* Moore [1859], as published in the binomen *Antheraea roylei*, is not invalid by reason of being pre-dated by a name based on a domestic form;
- (2) to place of the Official List of Specific Names in Zoology the following names:
 - (a) *roylei* Moore, [1859], as published in the binomen *Antheraea roylei*, with the endorsement that is not invalid by reason of being pre-dated by a name based on a domestic form;
 - (b) *pernyi* Guérin-Méneville, 1855, as published in the combination *Bombyx (Saturnia) pernyi*.

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Comments on this case are invited for publication (subject to editing) in the *Bulletin*; they should be sent to I.C.Z.N. Secretariat, Natural History Museum, Cromwell Road, London SW7 5BD, U.K. (e-mail: iczn@nhm.ac.uk).